CLAIMS

What is claimed is:

1. An article comprising:

a plurality of first heat transfer structures disposed in a matrix of a second heat transfer structure;

a solder preform disposed on the matrix; and

a transition between the matrix and the solder preform, wherein the transition is selected from an interface and a concentration gradient.

2. The article according to claim 1, wherein the matrix is a polymer, and wherein the plurality of first heat transfer structures is selected from graphite, diamond powder, inorganic dielectric particles, and metal particles.

3. The article according to claim 1, further including:

a middle heat transfer structure disposed between the matrix and the solder preform, wherein the middle heat transfer structure includes a composition that is transitional between the composition of the matrix and the composition of the solder preform.

4. The article according to claim 1, further including:

a middle heat transfer structure disposed between the matrix and the solder preform, wherein the middle heat transfer structure includes a composition that is transitional between the composition of the matrix and the composition of the solder preform, wherein the transition between the matrix and the solder preform includes a first interface between the solder preform and the middle heat transfer structure and a second interface between the middle heat transfer structure and the matrix.

5. The article according to claim 1, further including:

at least one particulate material in the matrix in addition to the plurality of first heat transfer structures.

6. The article according to claim 1, wherein the plurality of first heat transfer structures includes a concentration region in a portion of the matrix.

7. A package comprising:

a heat spreader;

a die disposed below the heat spreader; and

a heat transfer composite disposed above and on the die and below and on the heat spreader, wherein the heat transfer composite includes:

a plurality of first heat transfer structures disposed in a matrix of a second heat transfer structure, wherein the matrix is a polymer, and wherein the matrix is disposed on the die; and

a solder preform disposed on the matrix, wherein the solder preform is disposed on the heat spreader.

8. The package according to claim 8, wherein the heat spreader includes a cladding layer selected from nickel, nickel-copper, and gold.

9. The package according to claim 8, wherein the die includes a cladding layer selected from nickel, nickel-copper, and gold.

10. The package according to claim 8, wherein the die includes an active surface and a backside surface, the package further including:

a mounting substrate, and wherein the die is electrically coupled at the active surface to the mounting substrate.

11. A process of forming a heat transfer composite, comprising:

laminating a solder preform to a matrix to form a heat transfer susbsytem; and

bonding the matrix to the solder preform, wherein the matrix is formed by a process selected from:

co-extruding and singulating a plurality of first heat transfer structures and a second heat transfer structure; and

mixing, casting, curing, and singulating a plurality of first heat transfer structures and a second heat transfer structure.

12. The process according to claim 11, wherein the matrix includes a polymer, and wherein bonding includes a process selected from cold stamping and pressing under a heat load.

13. The process according to claim 11, wherein the matrix includes a polymer, and wherein bonding achieves the heat transfer composite with a transition between the matrix and the solder preform, wherein the transition is selected from an interface and a concentration gradient.

14. The process according to claim 11, wherein bonding includes supplying the solder preform material, selected from a base solder alloyed with an active element material, indium, tin, tin-indium, silver, tin-silver, tin-silver-indium, lead, tin-lead, lead-free solder, and combinations thereof.

15. The process according to claim 11, wherein bonding is carried out in a pressure range from about 200 pounds force to about 400 pounds force.

16. A method comprising:

disposing a heat transfer subsystem between a die and a heat spreader; and

bonding the heat transfer subsystem to the die and the heat spreader to form a heat transfer composite from the heat transfer subsystem, wherein the heat transfer composite includes:

a plurality of first heat transfer structures disposed in a matrix of a second heat transfer structure;

a solder preform disposed on the matrix; and

a transition between the matrix and the solder preform, wherein the transition is selected from an interface and a concentration gradient.

17. The method according to claim 16, further including:

before disposing the heat transfer subsystem between the die and the heat spreader, heating the heat spreader above ambient, wherein bonding is carried out for the heat transfer subsystem at a temperature of about (T_{TIM}-T_{AMB})/2, wherein T_{TIM} is the melting Centigrade temperature of the solder preform, and wherein T_{AMB} is the Centigrade ambient temperature.

18. The method according to claim 16, wherein bonding includes reflowing the plurality of first heat transfer structures against the die, wherein the plurality of first heat transfer structures is selected from a base solder alloyed with an active element material, indium, tin, silver, tin-silver, tin-indium, silver-indium, tin-silver-indium, and combinations thereof.

19. The method according to claim 16, further including:

disposing the die on a mounting substrate to form a package.

20. The method according to claim 16, further including:

coupling the die with at least one of an input device and an output device.

21. The method according to claim 16, further including:

coupling the die with a computing system included in one of a computer, a wireless communicator, a hand-held device, an automobile, a locomotive, an aircraft, a watercraft, and a spacecraft.

22. A computing system comprising:

a heat spreader;

a die disposed below the heat spreader;

a heat transfer composite disposed above and on the die and below and on the heat spreader, wherein the heat transfer composite includes:

a plurality of first heat transfer structures disposed in a polymer matrix of a second heat transfer structure, wherein the polymer matrix is disposed on the die; and

a solder preform disposed on the polymer matrix, wherein the solder preform is disposed on the heat spreader; and

at least one of an input device and an output device.

23. The computing system according to claim 22, wherein the computing system is disposed in one of a computer, a wireless communicator, a hand-held device, an automobile, a locomotive, an aircraft, a watercraft, and a spacecraft.

24. The computing system according to claim 22, wherein the die is selected from a data storage device, a digital signal processor, a micro controller, an application specific integrated circuit, and a microprocessor.